

Combustor Durability Evaluation with Use of Alternative Jet Fuels

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Cost Share Partner: Fuel producers, engine/airframe OEMs

Research Approach:

Develop radiative heat transfer measurement system for referee combustor

Initial experiments to evaluate operating points and sensitivity

Test fuels with varying composition

Objective:

Understand and characterize the **impact of fuel composition on gas turbine combustor liner lifetime**

Project Benefits:

Determine impact of alternative fuels on combustor liner lifetime

Quantify/qualify **potential benefits for combustor liner lifetime from alternative jet fuel use**

Minimize (hopefully eliminate) engine durability issues with use of alternative fuels

Major Accomplishments (to date):

This is a new project with no major accomplishments yet

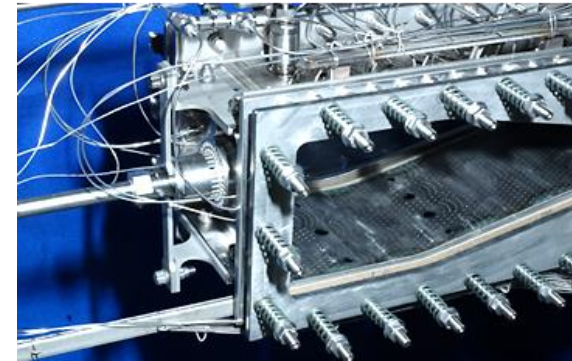
Future Work / Schedule:

Proceed with research approach toward beginning testing late 2021/early 2022

Primary Tasks

- Develop radiative heat transfer measurement system for referee combustor
 - Surface thermocouples, radiometers, infrared diagnostics
- Initial expts to evaluate operating points and sensitivity
 - High equivalence ratios & inlet air pressures
 - Evaluate high and low radiation loading
- Test fuel selection
 - Baseline Jet A, SAK, iso-paraffins, cycloalkanes and their blends
- Detailed measurements and data analysis/reporting
 - Guided by initial expts

Project in
collaboration with
AFRL



- Measure IR radiation & temperatures
- AFRL emissions trailer – gaseous & particulate emissions
- Vary fuels & fuel blends
 - Shell IH² – high cycloparaffin
 - NJFCP A1 – low viscosity, low density, high H content
 - NJFCP A2 – average fuel properties
 - NJFCP A3 – high viscosity, high density, low H content
 - Gevo ATJ – highly branched isoparaffin, low cetane
 - High Aromatic – synthetic aromatic kerosene and/or solvent
 - HEFA or FT fuel – paraffinic
- Test conditions
 - To encourage measureable radiation
 - Relatively high equivalence ratio
 - Relatively high pressure

Available Instrumentation

- Infrared Camera FLIR SC 6800
 - Optical access via single crystal sapphire windows
 - Side access to view the combustion gases
 - Top access to view the combustor surfaces
 - Windows ordered and expected by early June

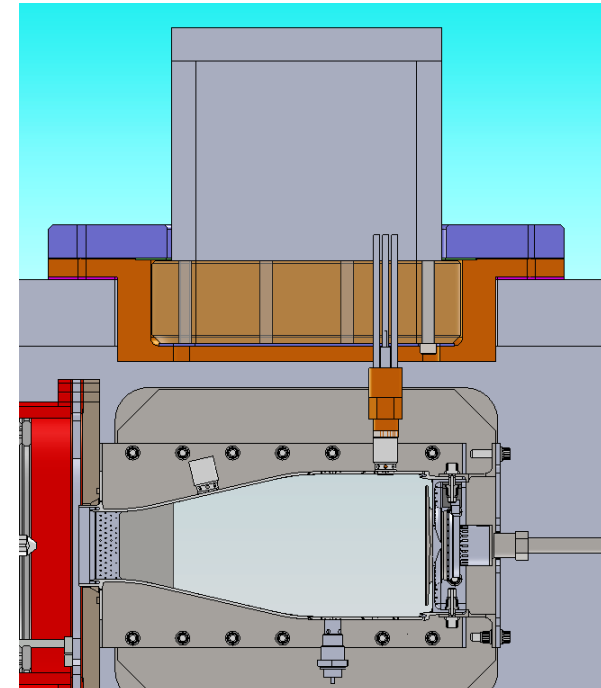


- Emission Sampling
 - Coordinated through AFRL
 - Turbine Engine Research Transportable Emissions Laboratory (TERTEL)
 - Particulate and gaseous emissions characterization

Instrument	Measurement
Condensation Particle Counter (TSI 3022A) CPC $\pm 20\%$	Particle Number
Scanning Mobility Particle Sizer (TSI 3936) w/TSI 3776 CPC $\pm 10\text{-}20\%$	Particle Size Distribution (D=7.0 - 289 nm)
FTIR Analyzer (MKS 2030) $\pm 2\%$	CO ₂ , CO, NO _x , SO _x , HC
CAI FID Analyzer $\pm 1\%$	THC
NDIR Analyzer (CA 602P) $\pm 1\%$	Diluted Sample CO ₂
Smoke Sampler & Reflectometer (Photovolt Instruments Inc. 577)	Smoke Number
Multi-angle Absorption Photometer ThermoElectron MAAP 5012	Particle Mass Concentration
LECO Carbon Analyzer (RC-612)	Elemental/Organic Carbon
Agilent GC-MS / EPA Method	HAPS
Agilent HPLC / EPA Method	Aldehydes-HAPS

Instrumentation - Radiometer

- Well established IR measurement technology
 - Measures incident radiation to the wall
 - Gardon Gauge – circular foil with sapphire window
 - One available – evaluating purchase
- Installation in referee combustor
 - Current clearance issue
 - Designing extension through vessel window

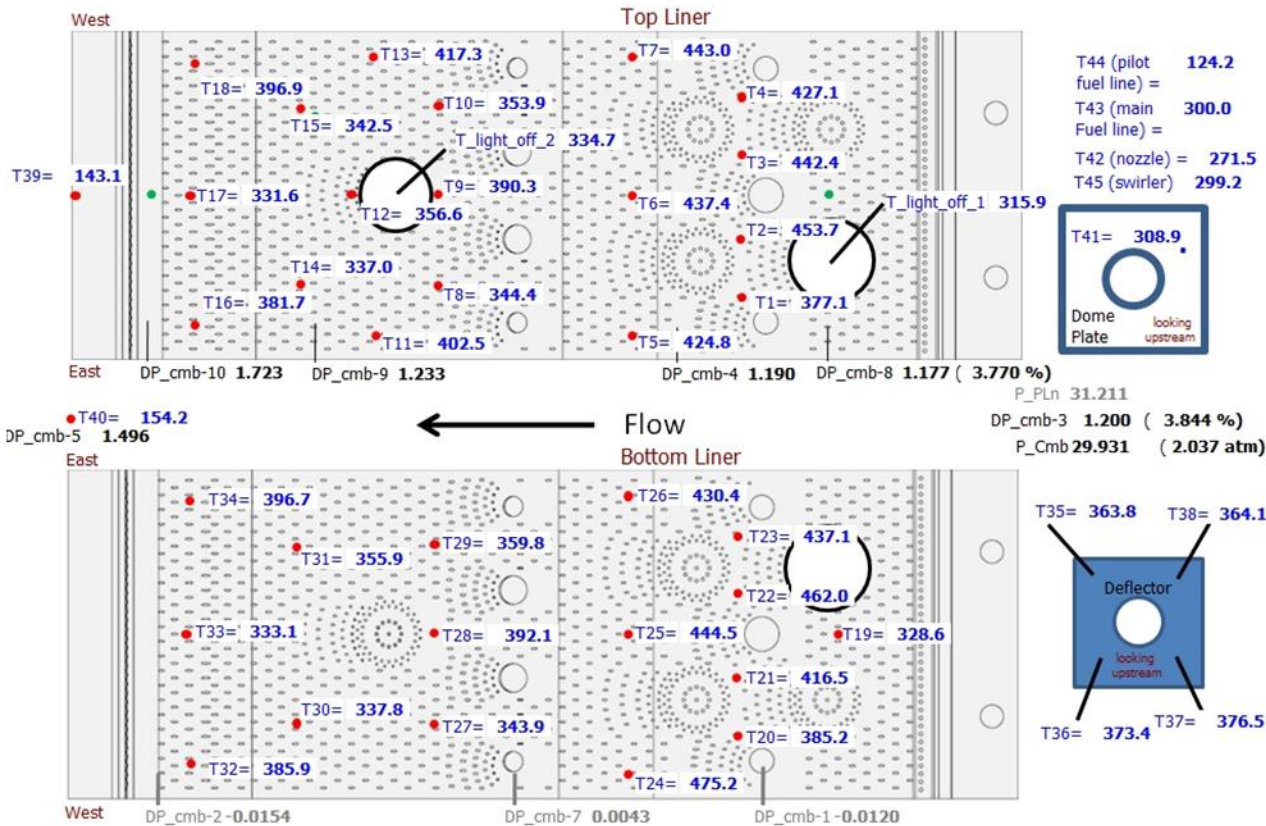


Backup Slides



Surface Thermocouples

Surface temperatures are complementary qualitative data for total flux to surface



Top view of combustor

Screen shot of data display of wall temperatures 45 wall temperatures (in blue text)